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THE UNIVERSITY OF TEXAS AT AUSTIN

25 January 1977

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SONAR TEST AND TEST INSTRUMENTATION SUPPORT

Quarterly Progress Report No. 2 under Contract N00140-76-C-6487
1 September - 30 November 1976

Dudley D. Baker et al.

NAVAL UNDERWATER SYSTEMS CENTER
Contract N00140-76-C-6487

APPLIED RESEARCH LABORATORIES
THE UNIVERSITY OF TEXAS

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25 January 1977

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APPLIED RESEARCH LABORATORIES
THE UNIVERSITY OF TEXAS AT AUSTIN
AUSTIN, TEXAS 78712

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I. INTRODUCTION

Applied Research Laboratories (ARL), The University of Texas at Austin, was awarded Contract N00140-76-C-6487, sponsored by the Naval Underwater Systems Center, New London Laboratory (NUSC/NL), effective 1 June 1976. Some of the work under this contract represents a follow-on effort to previous work sponsored by NUSC/NL under Contract N00140-74-C-6316.

The work under Contract N00140-76-C-6487 is divided into six task areas that focus on technical support in areas of sonar technology:

I. AN/FQM-10(V) Sonar Test Set Field Support

II. Transducer Repair Facility Test Site Field Support

III. AN/WQM-5 Sonar Test Set Field Support

IV. Special Purpose Passive Sonar Systems Support

V. Sonar Instrumentation Test and Evaluation

VI. Study of Towed Line Array Acoustical Testing at Transducer Repair Facilities

This report is Quarterly Progress Report No. 2 under Contract N00140-76-C-6487. Chapter headings in this report correspond to the six task areas. Additional chapters are included on documentation support, procurement of AN/WQM-5 components and field change kits, and AN/BQR-5 power supply development.

[redacted]

II. AN/FQM-10(V) SONAR TEST SET FIELD SUPPORT

A. Introduction

ARL provides material and technical support for six AN/FQM-10(V) sonar test sets located at three Naval shipyards with Transducer Repair Facilities (TRFs): Portsmouth Naval Shipyard (NAVSHIPYD PTSMH) at Portsmouth, New Hampshire; Mare Island Naval Shipyard (NAVSHIPYD MARE) at Vallejo, California; and Pearl Harbor Naval Shipyard (NAVSHIPYD PEARL) at Pearl Harbor, Hawaii. In addition ARL maintains a pilot AN/FQM-10(V) at its Lake Travis Test Station (LTTS).

This work is a continuation of previous efforts at ARL under Contract N00126-72-C-1748 and Contract N00140-74-C-6316, Task 0001AA. Quarterly progress reports issued under those contracts are applicable references for the present work.

During this report period, ARL has provided support for the test sets as described in the following paragraphs.

B. Support for NAVSHIPYD PTSMH

Upon request ARL furnished the AN/FQM-10(V) Ser 5 at NAVSHIPYD PTSMH with the following:

(1) two input signal relays for the CML power amplifier, unit No. 64,

(2) two operational amplifiers (Analog Devices 202) for the calibrator, unit No. 15,

(3) two relays (104 MPCX-14) for the pulse vector immittance meter sampler, unit No. 30, and

(4) two ARL constructed mounting brackets for the two Digitec digital thermometers.

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ARL received, repaired, calibrated, and returned the Tektronix model No. RM564 oscilloscope from the AN/FQM-10(V) Ser 5 at NAVSHIPYD PTSMH.

III. TRANSDUCER REPAIR FACILITY TEST SITE FIELD SUPPORT

A. Introduction

ARL provides material and technical support for the TRF test sites at three Naval shipyards: NAVSHIPYD PTSMH, NAVSHIPYD MARE, and NAVSHIPYD PEARL.

This work is partially a continuation of previous efforts at ARL under Contract N00140-74-C-6316, Task 0001AA, and the quarterly progress reports issued under that contract are applicable references for the work now continuing under Contract N00140-76-C-6487.

B. MX-9818/GQM-1 Adapter, Filling Fixture, Transducer

Three of the five valves on each filling fixture are to be replaced by more dependable bellows valves and this replacement will in turn necessitate a change in the connecting copper tubing. The fixtures will be modified to reflect the change as soon as ARL receives the valves.

C. Transducer Positioning Systems

Most of the work is in the detailed design and drawing stage. All of the design and assembly drawings have been completed and are now in the machine shop; a few parts have been completed. Some purchased items have been received, but the long lead items have not yet arrived.

IV. AN/WQM-5 SONAR TEST SET FIELD SUPPORT

A. Introduction

Naval Sea Systems Command (NAVSEA) assigned ARL the responsibility of being the designated overhaul point (DOP) for repairing AN/WQM-5 components. In addition to being the DOP, ARL also provides field maintenance engineering support for the 27 AN/WQM-5 Sonar Test Sets located at various Naval shipyards and laboratories.

During this report period, ARL has provided support for several of the test sets, as described in the following subsections.

B. AN/WQM-5, Ser A3, Sonar Test Set

Upon request ARL sent to NAVSHIPYD PTSMH one of each of the following printed circuit (P.C.) boards: No. 1A10, No. 1A12, No. 1A30, No. 1A31, and No. 1A32. All boards were returned unused except P.C. board No. 1A31, which had several failed components.

C. AN/WQM-5, Ser A4, Sonar Test Set

ARL sent one P.C. board No. 1A11 and one P.C. board No. 1A30 to NUSC's Dodge Pond test facilities, as requested by Mr. R. Handfield of NUSC/NL. Also, ARL sent to NUSC/Dodge Pond one 2 kHz to 4 kHz plug-in filter for the readout monitor in exchange for one 4 kHz to 8 kHz filter.

D. AN/WQM-5, Ser A11, Sonar Test Set

STC Ruebling of COMPACAREA COGARD requested one P.C. board No. 3A3 to replace his malfunctioning board. Also, he requested the loan of

ARL's signal generator while the Ser A11 signal generator was being repaired at ARL. The P.C. board and the Ser A8 signal generator were shipped to STC Ruebling in San Francisco.

E. AN/WQM-5, Ser A12, Sonar Test Set

Upon request ARL sent one P.C. board No. 8A6 to Mr. D. West of Naval Ship Engineering Center at Norfolk (NAVSECNORDIV). Later, during the same month, the power supply and power amplifier units received extensive electronic and mechanical damage. Both units were sent to ARL for repairs while NAVSECNORDIV used ARL's Ser A8 power supply and amplifier. The units were repaired, calibrated, and shipped back to Mr. West. The units were again being used with the Ser A12 test set when the power supply absorbed an irregular variation in the ac line voltage and, once again, the two units were damaged. The Ser A12 power supply and amplifier are at ARL being repaired at the time of this report.

F. AN/WQM-5, Ser A13, Sonar Test Set

Mobile Technical Unit No. 6 (MOTU 6), custodian of the AN/WQM-5 Ser A13 test set, requested technical assistance. Mr. G. Warren of ARL visited USS PUGET SOUND (AD 38), a destroyer tender, where the Ser A13 test set was located.

It was discovered that P.C. board No. 1A4 in the readout monitor, unit No. 1, had failed. A replacement was made and the unit was returned to operation. A complete test set inspection revealed a bad capacitor in units No. 9 and No. 10, two bad switching transistor P.C. board assemblies (No. 8A3 and No. 8A4) and a missing cable (W-13B). These items were furnished by ARL.

Later, when the test set was used to evaluate a transducer aboard USS BARNEY (DDG 6), it proved to be operating properly.

G. AN/WQM-5, Ser A17, Sonar Test Set

As requested, ARL furnished NAVSHIPYD MARE with a sample delay potentiometer (No. 1R1) for their readout monitor.

H. AN/WQM-5, Ser B1, Sonar Test Set

MOTU 4 in Groton, Connecticut, sent a Tektronix model No. 434 oscilloscope to ARL to be repaired and is temporarily using ARL's Ser 8 oscilloscope.

MOTU 4 also contacted Mr. G. Warren of ARL about a malfunction in their data recorder--the printout column No. 17 did not always print. Mr. Warren suggested pulling P.C. boards No. 3A5 and No. 3A6, cleaning the contacts on the edge connectors, and switching the positions of the two boards, which are identical. The cause of the problem could be determined by a process of elimination. If the problem was a bad component on P.C. board No. 3A5, column No. 12 would not always print. If the problem was a bad connection between the P.C. board and its connector, the problem would not recur. The problem proved to be the latter and was corrected. The data recorder was returned to operation.

I. AN/WQM-5, Ser B5, Sonar Test Set

Mr. D. J. Tucker, custodian of the AN/WQM-5, Ser B5, requested two P.C. boards (No. 1A9) for the readout monitor, four integrated circuits, and three transistors for the Tektronix model No. 434 oscilloscope. The items were sent by ARL via air express to meet Mr. Tucker's limited time frame.

V. SPECIAL PURPOSE PASSIVE SONAR SYSTEMS SUPPORT

This task was not funded in the original contract but was funded late in July 1976. ARL did not work on this task during this report period. It is expected that work will begin early in December 1976.

VI. SONAR INSTRUMENTATION TEST AND EVALUATION

A. Introduction

ARL participated in two projects under this task. The first project was the first article testing, at the Lake Travis Test Station (LTTS), of the AN/WQM-7 Sonar Test Set, previously called the Sonar Test and Evaluation Equipment (STEE). This project was completed and is described in section VI.B.

The second project, described in section VI.C., is the design of a replacement for the outdated AN/SQM-5 Sonar Noise Recorder.

B. Operational Testing of the AN/WQM-7 Test Set

ARL conducted tests on the AN/WQM-7 Sonar Test Set during 17 June - 16 July 1976. These performance tests were conducted with the AN/BQR-2, AN/BQA-8B, and AN/WLR-12 sonar systems aboard ARL's STEP Barge located at LTTS. The results of the performance tests were described in QPR No. 1 under this contract.

A classified report describing the AN/WQM-7 testing (ARL Technical Letter TL-EA-76-11 of 27 August 1976, revised 16 September 1976), forwarded to NAVSEA during the last report period, was revised to include a plot showing the dynamic range problem. The revised report and several additional plots were forwarded to NAVSEA by ARL ltr Ser E-198 of 17 September 1976.

C. AN/SQM-( ) Engineering Model

ARL began work on the design of a breadboard model of the AN/SQM-5 replacement in September 1976. The configuration that was chosen consisted of an HP 9825A programmable calculator, a Tektronix 4662 x-y plotter, a 2-speed synchro-to-digital/digital-to-synchro converter unit and an interface/true rms detector unit. The last two units will eventually be combined in a single unit.

The HP 9825A calculator was chosen as the system controller for the following reasons.

(1) The calculator has the speed necessary to read the data, compute the necessary parameters, and output the results in real time

(2) The additional memory available in the basic calculator allows long records of data to be stored during a noise plot. The data can be stored on a magnetic tape after the run is completed.

(3) The calculator has a built-in alphanumeric display for displaying program-selected parameters, such as bearing and true rms noise amplitude.

(4) The size and weight (25 lb) of the calculator allow it to be easily transported.

Because of these characteristics, the slightly higher cost of this calculator, as compared to the cost of the HP 9815A (described in QPR No. 1 under this contract), is more than offset by the reduction in other necessary hardware.

The Tektronix 4662 plotter was selected because of its light weight (30 lb), speed, and built-in functions, such as character generation. The unit's I/O structure is compatible with the IEEE 488 bus standard, which allows it to be plugged directly into the calculator.

The design and construction of the interface/true rms converter was completed by ARL on 24 November 1976. The synchro-to-digital/ digital-to-synchro unit was designed and built by C-Tech, Inc., Massena, New York. ARL personnel visited C-Tech, Inc., during the week of 18 October 1976 for the purpose of specifying the solid state synchro unit. By 19 November 1976, the synchro converter, composed of standard electronic modules, had been built and tested by C-Tech, Inc. The completed unit was received by ARL on 23 November 1976.

By 30 November 1976, all units of the AN/SQM-5 replacement had been interfaced, and development of the software necessary to acquire the data and make the required noise plots was nearly complete. Performance tests on the completed breadboard model are expected to take place at NAVSECNORDIV in early December 1976.

VII. ASSISTANCE WITH EXPANSION OF TRF CAPABILITIES TO INCLUDE NEW TRANSDUCERS

A. Introduction

ARL originally worked under Contract N00024-75-C-6070 to technically assist NAVSEA with the project to expand the capabilities of the Navy's three TRFs to encompass several new kinds of transducers, most of which are towed line hydrophone arrays. NAVSEA's plan is to equip the TRFs by FY 79 for repairing and testing the towed line arrays used with the following sonar systems: AN/BQQ-5, AN/BQQ-6, AN/SQR-18 (IETAS), AN/SQR-19 (ETAS), and AN/BQR-25 (STASS). In addition to these towed arrays, the plan includes equipping the TRFs to repair the transducers associated with the AN/WQM-5/6 Standard Acoustic Target Source (SATS) and the AN/WQM-7 equipment.

ARL's work began in 1975 as an extremely modest effort primarily to maintain liaison with the sponsors in NAVSEA headquarters who are responsible for the equipment and to gather technical information about the various transducers. This early work led to the assignment of two small tasks to ARL to continue this effort. In June 1976, a task was begun under Contract N00140-74-C-6316 to continue the study phase of the effort begun under Contract N00024-75-C-6070. A task under Contract N00140-76-C-6487 was funded at ARL in August 1976. However, the funding was received so late in the month that the effort actually began on 1 September 1976. The effort has been limited to a visit to the facility of one of the towed array manufacturers and visits to the TRFs at NAVSHIPYD MARE and NAVSHIPYD PEARL. In December, visits to another manufacturer and to NAVSHIPYD PTSMH will be made under Contract N00140-74-C-6316. In this way, the two modest efforts are mutually reinforcing as ARL continues to gain more information about the project. The following paragraphs describe more details of the effort under the subject contract.

B. Liaison with Seismic Engineering Company

On 22 September 1976, Messrs. G. E. English, P. S. Adair, E. Blum, and R. E. Brothers of ARL visited Hydroscience, Inc., and Seismic Engineering Company, Inc., both subsidiaries of Whitehall Corporation. Mr. J. Hayes, Systems Engineer of Hydroscience, Inc., was ARL's guide and only source of information during the visits. Hydroscience, Inc., under subcontract to Edo Corporation, is providing the towed line array used with the AN/BQR-18 system. Seismic Engineering Company, the sister company to Hydroscience, Inc., is actually the manufacturer of this array. Information was obtained about the function of the system, the kind and number of hydrophone elements, special features, and specifications and methods used for fabrication and testing. A detailed report of this trip is presented in Appendix A of this report.

C. Visits to the TRFs at NAVSHIPYD PEARL and NAVSHIPYD MARE

The TRF at NAVSHIPYD PEARL was visited during 4-5 November 1976 by Messrs. G. E. English, E. Blum, and R. E. Brothers of ARL and E. M. Spurlock of Stanford Research Institute (SRI). The towed line array repair/test (TLAR/T) work was discussed with Messrs. R. Shigeta, Combat Systems Electronics; P. Pollock, NAVSHIPYD PEARL Shop 67 Superintendent, and A. Perry, Assistant TRF Supervisor. Since the purpose of the visit was to establish liaison, details were not discussed. Items of interest and action from this meeting are detailed in Appendix B.

The TRF at NAVSHIPYD MARE was visited during the period 8-12 November 1976 by Messrs E. Blum of ARL and E. M. Spurlock of SRI. During 8-9 November, Messrs. P. D'Entremont and D. Schuler, TRF foremen, discussed the general form and layout of the TLAR/T work and pointed out to Messrs. Blum and Spurlock the two areas being considered for the TLAR/T facilities. During the period 10-12 November, a meeting was held to critique the TB-16/BQ Restoration and Repair Manual and to discuss the relationship of the TB-16/BQ and other TLAR/T work. A list of those attending the 10-12 November meeting and items of interest and action from the 8-12 November meetings are in Appendix B.

VIII. DOCUMENTATION SUPPORT

A. Introduction

ARL participated in three tasks in the area of documentation support, which focused on producing the Sonar Dome Handbook.

B. Revision of the "Sonar Dome Handbook, Volume V, Submarine Sonar Domes," NAVSEA 0967-LP-412-3050

During August a dozen draft copies of the Handbook were submitted to NAVSEA and NAVSEC for review. While this review was underway during September, ARL continued to refine the text. On 29 September, further changes and revisions required by the various groups within NAVSEA and NAVSEC were provided at a meeting at NAVSEC headquarters. These changes and revisions were compiled early in October and redrafting of the text and tables began. New illustrations for the AN/WLR-9 section as well as clarification about access to the AN/BQR-7 galleries on SSNs were obtained from NUSC/NL. By 30 November, the Handbook had been about 85% rewritten. Because of the in-depth review given to this material in September, each chapter, as it is being rewritten, is being made camera-ready. All chapters will have been submitted to NAVSEC for approval by the end of December. If the Handbook is satisfactory, it will be necessary to add only a table of contents, a list of illustrations, a list of tables, a glossary, and an index before it is printed. The appropriate preliminary work on these items has been done. Artwork for the covers is ready, except that this artwork must show the date on which input of technical data to the Handbook was completed. When this date is confirmed, covers can be ordered; delivery is expected within 4 to 6 weeks.

C. <u>Revision of the "Sonar Dome Handbook, Volume II, AN/SQS-26 Steel and Rubber Sonar Domes," NAVSEA 0967-LP-412-3020</u>

During this report period, the manuscript for Volume II of the Sonar Dome Handbook has undergone revision. The IBM Mag Card II machine was used to facilitate this revision. Editing and typing of this document have been completed, and the plastic covers have been received; however, additional work is required on several of the figures. It is expected that the manuscript will be ready for proofing by NAVSECNORDIV during the next report period.

D. <u>Revision of the "Sonar Dome Handbook, Volume IV, AN/SQQ-23 Rubber Sonar Domes," NAVSEA 0967-LP-412-3040</u>

The manuscript for Volume IV of the Sonar Dome Handbook is complete. Two copies of the new manuscript were sent to NAVSECNORDIV on 12 November 1976 for review. As soon as the manuscript is approved, ARL plans to reproduce 200 copies.

IX. AN/WQM-5 PROCUREMENT AND FIELD CHANGE PROGRAM

A. Procurement of AN/WQM-5 Series Field Change Kits

Because of many delays in obtaining purchase approval and the lengthy procurement cycle at The University of Texas at Austin, a purchase order for AN/WQM-5 Field Change Kit components was not issued until 2 November 1976. The purchase order was awarded to C-Tech, Inc., of Massena, New York. The field change components procured under Contract N00140-76-C-6487 are supplemental to those being procured simultaneously under Contract N00140-74-C-6316. The total field change program is as follows.

10 AN/WQM-5A Field Change Kits
5 AN/WQM-5B Field Change Kits
5 AN/WQM-5C Field Change Kits

In the same procurement, one AN/WQM-5A Field Change Kit for Spain is being purchased (see section B).

An integral part of the hardware for the field change kits is a quantity of programmable calculators and plotters that ARL will obtain directly from Hewlett-Packard and will integrate with the items obtained from C-Tech, Inc. An OEM agreement has been negotiated and was signed on 2 December 1976. Thus, it is expected that the equipment from Hewlett-Packard will be ordered in December 1976.

B. Procurement of an AN/WQM-5A Sonar Test Set for Spain

All components of the AN/WQM-5A for the Spanish Navy are on order. QPR No. 1 reported that the original AN/WQM-5 components were ordered in June 1976. The new AN/WQM-5A components were included in purchase orders discussed in section A. Only the lot of spare parts is not on order at present. It is expected that these items will be identified and ordered in December 1976.

[redacted]

X. AN/BQQ-5 SWITCHING POWER SUPPLY

A. Introduction

ARL was tasked under Contract N00024-74-C-1069 by NAVSEA Code 660F to perform a study of the current switching power supply (built by IBM) which is used in the AN/BQQ-5 sonar system. This basic study has progressed to a new design proposed by ARL that should make the reliability requirement of 100,000 h MTBF a reality.

The work under Contract N00140-76-C-6487, a follow-on to the original study, requires ARL to fabricate and demonstrate a model of the proposed new supply.

B. Basic ARL Design

ARL has designed a switching power supply for the AN/BQQ-5 sonar system to meet the required 100,000 h MTBF. This improvement is made possible by the use of fewer parts, a different circuit design which includes redundancy, and use of state-of-the-art electronic components.

The "flyback" technique in switching design has properties that make it much more reliable than the "bridge" or "half-bridge" designs; that is, the input is completely isolated from the output. This feature allows paralleling of power stages (redundancy) without interaction. Also, the paralleled stages can be energized out of phase, reducing the ripple current required for the input and output filter capacitors.

The power switching module shown in Fig. 1 is the basic building block for the supply. Figure 2 shows the switching power supply module waveforms. The power transistor (MJ 10005) will be operated within the

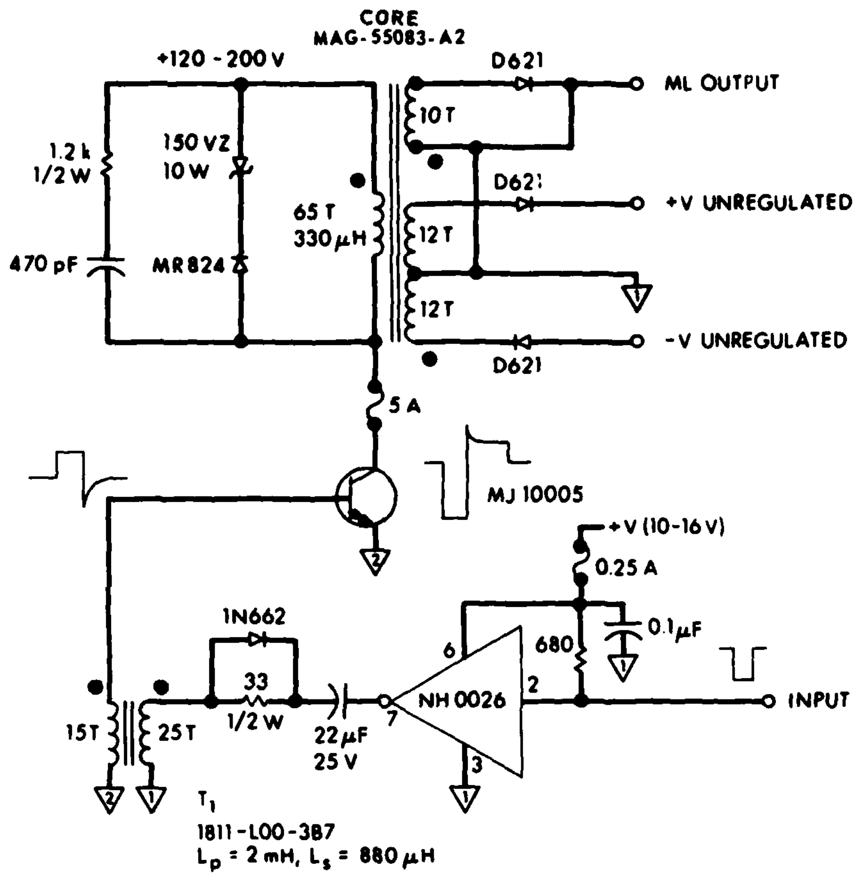
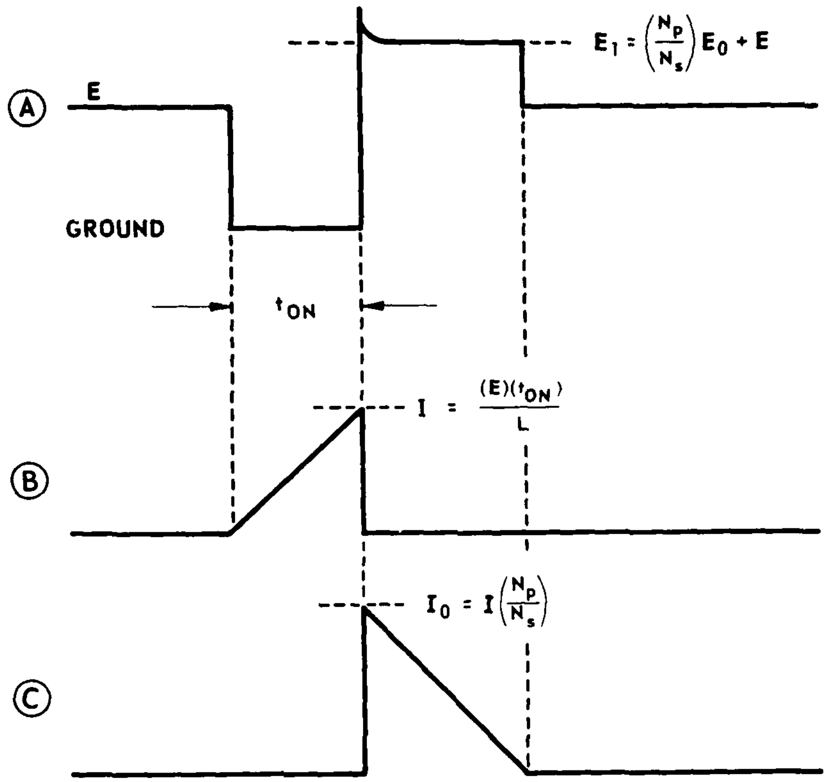


FIGURE 1
SWITCHING MODULE

ARL - UT
AS-77-39
BSS - DR
1 - 25 - 77



E = SUPPLY VOLTS (dc)
I = PEAK AMPS INPUT
I_o = PEAK AMPS OUTPUT
N_p = PRIMARY TURNS
N_s = SECONDARY TURNS
E_o = OUTPUT VOLTS

FIGURE 2
SWITCHING POWER SUPPLY MODULE WAVEFORMS

ARL - UT
AS - 77 - 40
BSS - DR
1 - 25 - 77

[redacted]

published safe operating area (SOA). The switching speed is fast for high efficiency and the input drive requirements are well controlled and do not strain the "housekeeping" supply, which is an independent power source of relatively low power used to drive the output stage and perform other sense and feedback functions.

The driver (NH0026) in the switching module is a monolithic circuit capable of driving ±1.5 A in a switching mode. Thus, there is little dissipation in the chip (approximately 0.25 W) and only one external part is required. Isolation is achieved by driving the base of the output transistor with a small transformer and having secondary windings on the power storage element ("flyback" transformer).

In the "flyback" operation, some stored energy is lost due to leakage inductance of the power transformer and the turn-on time of the output diodes. The result of this loss shows up as a high voltage spike on the collector of the power transistor. If this spike is not snubbed at a voltage below V_{ceo} of the transistor, second breakdown will occur and the transistor will cease operating.

Each of the output diodes on the switching module isolates itself from other modules that are in parallel with it. If no energy is transferred to the secondary because of some failure in the module, then the output diodes remain back-biased.

Since the switching modules are under the greatest stress in the power supply, redundancy will increase the reliability. There are several tradeoffs involved but the best compromise is having any two switching modules out of four be able to handle the full load. This means that, if all four modules are operating at full output, the supply could produce twice the power required. Under all operating conditions, each module handles its share of the load.

Input and output filter capacitors must operate near their maximum rated rms ripple current. Redundant switching modules reduce the current. By phasing the drive to each module, the contribution to the rms ripple current is lowered. With two modules operating, the current is lowered by 30%; with three modules operating, the current is lowered over 50%; and with four modules operating, the current is reduced by 65%. Both input filter capacitors and output capacitors must be paralleled to handle the worst-case ripple current, which is undesirable since it reduces reliability. The best solution at this time is to use more capacitors (each fused) than are needed so that, in case of either a short or an "open," the number of operating capacitors is reduced by one and the failure does not shut down operation.

The housekeeping supply is a nonswitching, totally redundant design. Two linear, single phase 6 VA transformers, each on a different phase of the input 3-phase line, have separate rectifiers and two output capacitors. Fusing is chosen so that a failure of any component either opens or blows a fuse, and the supply continues to work.

The voltage reference, sensing, shutdown, startup, and associated circuitry should be reliable, but sections that are not redundant should be kept to a minimum number of parts; also, redundant sections must be isolated from each other or the redundancy does not improve the reliability.

Use of a chip (SG 1524) reduces the number of discrete components enough to allow the use of redundant chips (SG 1524) to further increase the reliability.

C. Present Status

ARL has executed the new switching design to conform to the physical requirements by using plug-in printed circuit cards. Each card has an integral heatsink which greatly increases the shock resistance and heat dissipation of the supply.

One of the critical heat dissipation problems is related to the ripple current carrying capability of both input capacitors and the output capacitor. This capability is directly related to temperature. Because capacitors are also difficult to shock mount, methods of mounting were studied so that the heatsink would not be bulky and would be easy to manufacture.

The basic power supply (with two driver modules) has been built to the configuration of the type 4-B supply. The circuitry to perform the necessary housekeeping functions has also been constructed but the start-up overload and normal operation circuitry are still on the drawing board.

The concurrent work on the reliability study is progressing at a rapid rate. The MIL 217-B program of the ARL design is approaching the final stages; it should be possible to start varying parameters in the next quarter and to have a full-blown printout covering all aspects of the design by the end of March. Preliminary data on the driver module indicate an MTBF of 600,000 h, including the redundancy of two out of four modules.

D. Design Review by Instruments, Inc.

Messrs. E. English and B. Shaw visited Instruments, Inc., on 21 October 1976. The basic structure and circuits of the new design were explained to Mr. M. Fry, who previously evaluated the IBM design. ARL has retained Instruments, Inc., as a consultant on this work, and the design review was completed by the end of the report period. The report resulting from the design review is included in Appendix C.

E. Demonstration at NAVSEA

A basic working supply in a dummy package was demonstrated to Messrs. D. Baird, J. Archer, and B. Daney at NAVSEA Headquarters. The demonstration was to show that the new design could fit within the physical envelope of the type 4-B supply. Several advantages of the new supply were immediately obvious: (1) all cards can be plugged in, making the supply field-repairable, (2) bids could be sent to vendors on a card basis, which would encourage competition, (3) there will be no "soft" wires in the supply, and (4) the reliability should be much higher than that of the present supply.

It was determined that a complete working model should be built at ARL and tested at IBM late in March 1977. The mechanical and temperature requirements would be eased (no shock or full temperature excursions) for the March 1977 tests.

APPENDIX A

TRIP REPORTS TO HYDROSCIENCE, INC., AND TO SEISMIC ENGINEERING COMPANY

22 September 1976

APPLIED RESEARCH LABORATORIES

INTEROFFICE MEMORANDUM

DATE: 27 September 1976
REB:wa
TR-13

FROM: Richard E. Brothers

TO: Electroacoustics Group File

SUBJECT: Trip to Hydroscience, Inc., Dallas, Texas, 22 September 1976

Accompanied by Messrs. G. Earle English, Robert S. Adair, and Eugene Blum, I traveled to Hydroscience, Inc., Dallas, Texas, on Wednesday, 22 September 1976, for consultation with Mr. Jerry Hayes, System Engineer for the AN/SQR-18 Towed Array.

Drawings and specifications for the AN/SQR-18 Towed Array are not available to our people at this time. Mr. Hayes stated that he expected to receive a contract in November 1976 that would allow him to release drawings and specifications to ARL/UT. Mr. Hayes' telephone number at Hydroscience, Inc., is (214) 630-0911. The AN/SQR-18 is a "can you give it to us now" type project, according to Mr. Hayes, and drawings are not in a releasable form. The following information was released to us verbally by Mr. Hayes.

The AN/SQR-18 Towed Array consists of three modules, one sensing module, and two vibration isolation modules (VIMs). The array has a total length of 670 ft, is 2.7 in. in diameter, weighs 1700 lb, and is stored on a 300 lb reel. The AN/SQR-18 is neutrally buoyant; this is accomplished by filling with NORPAR-12, an isoparaffin produced by Exxon. The array is manufactured by Seismic Engineering Company of Dallas, Texas. Specifications are not available from Hydroscience or Seismic but could possibly be obtained from Edo Corporation in New York, New York.

The sensing module is 225 ft long and 2.7 in. in diameter and weighs 600 lb. The AN/SQR-18 sensing module uses Multidyne MD-2 hydrophones. The MD-2 has four elements; we were not informed how they are internally connected. Externally, two wiring studs are available;

a twisted pair is connected to these. Edo Corporation has the confidential specifications of the MD-2. The hydrophone is supposedly nonrepairable and Seismic will not sell hydrophone components. The physical load of the sensing module is carried by three 5/32 in. in diameter galvanized improved plow steel cables. These cables are held in position by spacer floats, made out of Lexan or polypropylene. The spacing of these floats is not available; the spacers are fastened to the cable by soldering.

There are two VIMs; each has a length of 220 ft and a diameter of 2.7 in. and weighs 550 lb. The shock absorber used in the VIM is nylon rope (three strands are used), which will stretch 2 to 2 1/2 times its length. The rope is specified by Edo Corporation. The rope is held in position by the same spacers used in the sensing module, and the spacers are held in place by crimps on either side. The wire bundle in the VIM is 150% in length and is looped and held in place by rubber bands when it is being put into the shell. These rubber bands dissolve when the shell is oil filled.

Both the sensing module and the vibration interface modules are encased in a polyurethane shell, which is the casing that holds the oil fill. A vacuum is pulled on this shell so the modules can be slipped in easily. The skinning pipe used to apply this vacuum is 4 in. in diameter and is heated for winter use.

We left for Austin at 1535 h and arrived here at 1610 h.

Richard E. Brothers

Richard E. Brothers

Copy to

Robert S. Adair
Eugene Blum
G. Earle English
Bill S. Shaw

APPLIED RESEARCH LABORATORIES

INTEROFFICE MEMORANDUM

DATE: 30 September 1976
EB:wa
TR-14

FROM: E. Blum, G. E. English, R. S. Adair, and R. E. Brothers

TO: Electroacoustics Group File

SUBJECT: 22 September 1976 Travel to Hydroscience, Inc., and Seismic Engineering Company, Subsidiaries of Whitehall Corp.

Arriving at Hydroscience, Inc., near the beginning of the working day, we contacted Jerry Hayes, a systems engineer and "sole survivor" at Hydroscience on the AN/SQR-18 project, who was our guide and answer man for the tour. Jerry came on with a basically disinterested attitude; he offered no information but answered direct questions pretty well, except those that he thought would appear in the Cat E drawings which he expects to get money to prepare. He was also reluctant to answer questions which he felt were answered by the Edo contract specification. He said that Edo Corporation anticipates sending them money for these drawings near the beginning of December 1976. His Edo, New York, contacts are Jonathan Shere and John Vinsinzo, (212) 445-6000. Jerry Hayes' Hydroscience, Inc., number is (214) 630-0911.

The first part of the morning was spent in the conference room at Hydroscience with the sample towed array section and PR-type movie and the second part of the morning was spent at the Seismic Engineering manufacturing plant. The first part of the session in the conference room was spent using the sample towed array section as a basis of discussion. Then he showed the movie. The movie was reshown and used as a basis of discussion and was stopped whenever anybody had a question. The following is a disjointed list of items we picked up in the conference room.

1. Jerry feels that basically we will need a copy of the list of basic manufacturing facilities in order to restore and repair the AN/SQR-18.
2. The filling fluid is an Exxon isoparaffin called NORPAR-12 with the specific gravity of 0.65 or so (depending on requirements for neutral bouyancy).
3. The cable is 5/32 in. galvanized improved plow steel (3 ea.) using standard aircraft swaging techniques, eyes, etc.
4. There is no oil processing; nothing is cleaned before it is assembled. Dirt can be seen "roaming around" inside the oil in the sample towed array section.
5. The elements are Seismic MD-2. All of them are hardwired with a twisted pair.
6. The wire is No. 26 or 30 in the sensing module. (Jerry didn't respond to the question about the insulation.)
7. Apparently, the way the array is put together, oil can "hose" up the wire, and oil can even hose up the 2-cable wire.
8. The tow cable is off the Vector shelf. Seismic terminates the wet end and Edo terminates the dry end.
9. The AN/SQR-18 gets no tension testing; they merely test the swaging tool performance every so often.
10. It takes 30 sec to solder each place where the steel cable is attached to a spacer.
11. It costs $7/ft for the strength members, spacers, and skin.
12. The tow cable armour is contrahelically wound.
13. The elements are essentially nonrepairable. Seismic would probably sell the whole MD-2 but not any of the parts.
14. The spacers in the 18 are Lexan but Seismic also uses polypropylene or syntactic foam.
15. Solder volume in the spacers and other things like the specific gravity of the filling fluid are used to adjust the neutral buoyancy of the towed array.
16. There is no test, as such, for saltwater infiltration.

17. Repair of spacers would have to be determined and done on an individual basis since spacers are hard to get out and replace.

18. Seismic's calibration work is done at Leesburg. Based on the results of the calibration, a slight change of sensitivity occurs with pressure.

19. The nylon rope (capable of 250% stretch) in the VIM is designed on an individual-as-needed basis (towing speed, etc.) and is held in place with National Telephone crimp fittings on both sides of each spacer. The wire is put in the VIM at 150% length (tied initially with rubber bands which dissolve or untie in the oil after booting and oil filling.) The plastic sheet stretches with the nylon at least as far as the design calls for. The nylon rope appears to be "Goldline" (high quality) climbing rope.

20. The booting on the 18 is polyurethane. Small repairs can be accomplished by merely cutting off a small section of boot, making the repair, and replacing the cut-out section with a stretched overboot.

21. For major repairs, the skin is disposable.

22. Noncorrosive flux is used in all government work; otherwise acid flux is used on the solder.

23. The main failure mode of the modules is physical damage.

24. The "thing" is always oil filled in the vertical mode by snaking the array over a series of "nails" in the wall described later in this report. Vacuum is apparently not necessary since all bubbles can be seen and can be shaken out by hand.

We then drove to Seismic Engineering Company and viewed the towed array manufacturing area (but missed the calibration room which Jerry described verbally in 25 words or less on the way back to Hydroscience). The manufacturing area at Seismic was a very simple affair. Major points noted are as follows.

1. Urethane varnished work benches made of chip core divided area into two work spaces about 8 in. wide; the back lip is about 2 in. high and the front lip is about 1/2 in. high; two of the benches are back to back with a 5 in. inner tray.

2. Other work benches are maybe a total of 22 in. wide divided down the middle. If the work bench isn't full length, enough width is necessary to allow the array to double back on itself several times. Also, plywood tables are used. The cable bundle is held in air under tension for wirewrapping over 10 to 12 ft span.

3. The cable is hand tensioned even when it is lying on-bench for most work.

4. Tables do not have electric outlets along them except where they are using soldering irons on the aircraft cable.

5. Unraveling lacing technique used. Tied very hard near the breakout points for the hydrophones.

6. The "4 in. skinning pipe" (booting fixture) stretches way out into Seismic's back lot and is capable of skinning about 100 m. The end is stuffed over a mandrel which has an inside diameter large enough to accept the array. The boot is pulled through by a rope or string and then a big piece of waterhose is used to connect the outside of the mandrel/boot connection to the outside of the pipe with hose clamps. A pig is blown through and the array is pulled in from a snake arrangement on the floor after the vacuum is pulled.

7. White deposit (zinc oxide) on the galvanized cable sent back for repair appears to be considered normal here. I think it could be due to moisture and air carried by the filling fluid (isoparaffins are fairly hygroscopic) or maybe to saltwater infiltration.

8. They haven't tried coiling the skinning tubes to conserve floor space and don't particularly care to.

9. Jerry thinks that somebody like Western Electric uses a pressure outfit rather than a vacuum skinning device and they put the oil in and everything in that one move.

10. The skinning pipe appears to be 4 in. standard pipe. They use heaters in the winter for stretching the boot because when it gets cold it doesn't stretch very well. Heating is accomplished with heating tape under insulation all down the skinning tube in about 12 ft sections.

11. The elements are single-end mounted using the sheet metal screws in the holes provided in the spacers.

12. Various parts are stored rather haphazardly under the workbenches: boxes of swages, boxes of plastic hydrophone inserts, coils of the nylon rope, the separators, etc.

13. The wire is on racks that have wheels for stripping to make a new bundle.

14. Somebody actually sits around and cuts the rubber bands into lengths so that they can be tied and used. Hot blow gun is used for heat shrink on the connectors.

15. The need for the jigs and fixtures for the aircraft cable connectors hopefully will not exist at the TRFs but the fixtures are definitely necessary if cable and replacement is necessary.

16. Wiring diagram comes with each cable.

17. The length of hangers on the wall for vertical filling of the array is about 40 ft long and the protected hangers are about 6 or 8 in. long and about 4 ft apart and about 6 ft high.

18. 24 in. is the absolute minimum storing diameter for the VIM. The bigger the better. Normal handling, say a 4 ft diam. On the workbench it is not as critical, apparently, for short term operation.

19. They find a spool of heavy twine very handy especially near the end of the workbenches.

It was generally agreed that many of Seismic's methods are not economical for manpower or floorspace. There's got to be a better way.

G. Earle English

Eugene Blum

Robert S. Adair

Richard E. Brothers

APPENDIX B

TOWED LINE ARRAY REPAIR/TEST (TLAR/T)

(1) Items of Interest and Action from
4-5 November 1976 Meeting
NAVSHIPYD PEARL TRF

8-12 November 1976 Meeting
NAVSHIPYD MARE TRF

(2) Attendance List for
10-12 November Meeting at
NAVSHIPYD MARE

[redacted]

TOWED LINE ARRAY REPAIR/TEST (TLAR/T)

Items of Interest and Action from
4-5 November 1976 Meeting
NAVSHIPYD PEARL TRF

1. ARL received six NAVFAC drawings of Bldg. 214 as follows:

Drawing No.	Title
1160 709	Civil: Site Plan
710	Architectural: Partial First Floor Plan
711	Architectural: Partial First Floor Plan
712	Architectural: Partial Second Floor Plan
713	Architectural: Partial Second Floor Plan
714	Architectural: Partial Third Floor Plan

These drawings are sheets 1-6 of 64. Drawing 709 has a complete drawing list so that we can obtain more information as necessary. These plans will enable ARL to lay out floor plans for the proposed TLAR/T site. Also, small sketches of the first, second, and third floors were obtained with markings indicating the present TRF on the first floor and the proposed addition on the second floor.

2. During the tour of Bldg. 214, P. Pollock (NAVSHIPYD PEARL Shop 67 Superintendent) indicated that the floor space actually available was somewhat more flexible than indicated on the sketches. An addition to Shop 67 is due to be built in FY 79. The actual ramifications of this addition are not yet clear.

3. ARL verbally presented a broad outline of ARL's task and extent of the TLAR/T function. Except for the need for a straight run with 225 ft booting fixture, ARL was unable to give NAVSHIPYD PEARL TRF any detailed information about the quantity or type of floor space required. It was generally agreed that ARL would keep the TRF informed as plans become more definite.

Enclosure (1) to
EAG Trip Report
Ser TR-EA-1

[redacted]

4. Mr. Pollack indicated that, with the possible exception of the megohmmeter and very common hand tools, the TRF would like to see all new, dedicated equipment for TLAR/T. When given a choice between having the electronic test equipment separate or mostly confined to a rolling panel rack, they chose the panel rack without any hesitation.

5. Of note is the fact that NAVSHIPYD PEARL TRF is by far the smallest and most ill-equipped TRF of the three. It handles perhaps 12% of the total work volume. Transducers are stored outside, in the sun. The test tank is only 30 ft high and does not have an adequate walkway. If in-water testing is to be done in the tank, a walkway, perhaps similar to the ones at NAVSHIPYD MARE and NAVSHIPYD PTSMH, will have to be built. Structural drawings of Bldg. 214 will have to be obtained, if this is true. A larger instrumentation house would also be appropriate.

6. Since the weather at NAVSHIPYD PEARL is very clement year around, some of the equipment could be installed outside. This equipment could be protected by a large open leanto which could also be used to help cover the shipping/receiving/storage area.

TOWED LINE ARRAY REPAIR/TEST (TLAR/T)

Items of Interest and Action from
8-12 November 1976 Meeting
NAVSHIPYD MARE TRF

1. ARL received two copies of three NAVSHIPYD MARE drawings of machinery arrangement for Bldg. 866, sheets 1 (first floor), 3 (second floor), and 4 (third floor) of 6. On one of the copies, the first floor drawing is delineated by an area that may be set aside for TLAR/T. ARL was also given a taped-together Xerox copy of a large air-conditioned section of Bldg. 627 being considered for TLAR/T, which is located about 2 miles north of Bldg. 866. This particular area is more like a 400 ft by 200 ft cave.

2. ARL verbally presented a broad outline of ARL's task and the extent of the TLAR/T function. Except for the need for a straight run with 225 ft booting fixture, ARL was unable to give NAVSHIPYD MARE TRF any detailed information about the quantity or type of floor space required. It was generally agreed that ARL would keep the TRF informed as plans become more definite.

3. Schuler requested an overall "people tree" starting with Herman and going through vendors, NAVSEA responsibility, ARL, shipyards, SRI, NUSC/NL, and everyone else involved with this effort. ARL indicated this tree might be ready in time for the January TRF meeting.

4. The only reasonable place in the area alloted in Bldg. 866 for the booting fixture is attached to column row E (on the column row D side) approximately 13 ft off the ground with work platforms at both ends. The SW end of the fixture cannot extend past column E8 because it would interfere with the rail tracks. It must be 13 ft high to avoid interfering with the path to the elevator between E11 and E12.

Enclosure (3) to
EAG Trip Report
Ser TR-EA-1

5. It was suggested that reel stands for handling all arrays be of a common variety and perhaps of the same variety as the installing activity. When given a choice between having the electronic test equipment separate or mostly confined to a rolling panel rack, Mr. Schuler chose to have the equipment separate.

The following items were brought out at the TB-16 Restoration and Repair Manual meeting.

6. The restoration and repair manual is not adequate as written. Major points brought out included the need for a working specification for most of the electronic instruments in addition to a recommended up-to-date vendor model number and better descriptions of the specialized work areas, jigs, and fixtures.

7. Three TS-3575/BQ's were already being purchased and sent to the TRFs. ARL should talk to NAVSEA 06H4-3 (V. Graves) about routing one or more of these through ARL.

8. Cliff Porterfield had done an 11 page "nitpick" critique of approximately 3/4 of the R&R manual. ARL is to respond to the R&R manual in 30 days if ARL has any further comments.

9. ARL is now on the mailing list for R&R manuals, ILS plan revisions, maintenance plans, support equipment list, and interim repair parts lists, etc., concerning the TB-16.

10. Common items between the intermediate maintenance areas and the TRFs include the test set (TS-3575), a portable fill and pressure rig for oil, roller racks, and jack stands.

11. Bob Mahnke, NUSC/NL, is the man to see about the TS-3575 manual.

[redacted]

12. Drawings for the TB-16 will be forthcoming. A sample section of the TB-16 may be available in 6 mo.

13. McGonegle says to talk to Dave Cain, the in-house NUSC/NL man at CID. ARL will call McGonegle next week and have him set up the tour with Dave Cain.

14. There is now a "stabilized" man-day rate per man-day with a cost included at NAVSHIPYD MARE.

15. The 3-element cluster in the TB-16 is a throwaway and uneconomical to repair.

16. NAVSEA has moved to National Center Bldg. 2 and all the telephone numbers have changed.

17. The exact testing to be done at the TRFs is to be determined at ARL with advice and comments from everyone else concerned.

18. Porterfield specifically requested an inspection table which would allow the array to be rolled circumferentially as well as axially.

ATTENDANCE LIST

10-12 November Meeting at NAVSHIPYD MARE

Name	Representing	Telephone
S. Shimomura (BQQ-5 ILS)	Hydrotronics, Inc.	(703) 790-527
Ron See	Hydrotronics (Anaheim)	(714) 776-5051
J. R. McGonegle (BQQ-5)	NAVSEA 660F-52	(202) 692-0988
E. M. Spurlock	SRI - STEP Liaison with MARE & PEARL TRs	(415) 326-6200
R. C. Long	NAVSEA 04312	(202) 436-1693
Eugene Blum	ARL/UT	(512) 836-1351
Frank Peglow	NAVSHIPYD MARE Shop 67	(707) 646-2354
Al Carey	NAVSHIPYD MARE Code 270	(707) 646-2575
Cliff Porterfield	NAVSHIPYD MARE Code 270-3 TRF	(707) 646-2575
Herman Evans	NAVSEA 06H4D	AV 222-7894

Enclosure (5) to
EAG Trip Report
SER TR-EA-1

APPENDIX C

DESIGN REVIEW OF A SINGLE-ENDED AN/BQQ-5
POWER SUPPLY

[redacted]

INSTRUMENTS, INC.
DAVID C. KALBFELL, Ph.D.—President
3432 MIDWAY DRIVE
SAN DIEGO, CALIFORNIA 92110
(714) 223-7156

Established 1941

October 28, 1976

DESIGN REVIEW OF A SINGLE ENDED AN/BQQ-5 POWER SUPPLY

For Applied Research Laboratories - University of Texas

Michael N. Fry

INTRODUCTION

Earl English and Bill Shaw visited Instruments, Inc. on October 21, 1976. They brought schematics for a 400 W switching power supply and a prototype switching module.

Mr. Shaw explained his design philosophy and reported on measurements taken on breadboarded modules in Austin. We conferred on current limit and start-up circuitry.

We have been asked to review the circuitry as thus far developed.

OVERVIEW

The approach has impressed us very favorably. New components have made a reduction in total parts count and an increased redundancy possible.

Novel techniques allow the redundant switching modules to operate in quadrature to reduce both switching currents and output ripple voltage.

Our main criticisms are that adequate short and start-up circuitry has not been developed, and that the interconnection of the redundant modules may eliminate the redundancy. (i.e. A failure in one module may effect one or more of the other three)

DISCUSSION

INPUT RECTIFIER AND FILTER - Fig. 1

This is basically the same as the existing BQQ-5 supply. The capacitors are individually fused so that a single failure will not shut down the supply. Selection of the proper capacitor is most critical. Two possibilities are the Sprague type 604D and the Tansitor type AT.

The fuses should have a 200 volt rating to allow proper clearing.

HOUSEKEEPING SUPPLY - Fig. 2

This supplies 10 - 16 V, at about 4W. The unregulated 120-200 volt output of the input rectifier is used as a reference to allow proper timing for the switching module.

We understand that a small 60 Hz isolation transformer is being considered for this application. This could be very beneficial, reducing parts count (20% of total) and improving efficiency. The main drawback to such a transformer is quality control associated with the thousands of turns of very small wire which is required. This approach should be seriously explored, but only if vendors can demonstrate very high reliability.

The switching regualtor being considered in Fig. 2 should have a current limit resistor in the emitter of the MJ10001 and should be tied to pins 4 & 5 of the SG1524 to aid in start-up.

We feel that suitable line voltage information can be obtained from the reverse voltage on the housekeeping transformer winding. This would allow fixed voltage regulation and remove some of the uncertainties in the switching module base drive at the line voltage extremes.

The inputs and outputs should be fused, not only to maintain redundancy, but to guard against an insulation failure in the transformers.

SWITCHING MODULE - Fig. 3

The single-ended inverter requires higher peak voltage and current in the transistor than the half-bridge approach, but a single Darlington transistor has twice the rating necessary in this application. Also the ease of paralleling modules and the simplified drive circuitry makes this a very attractive choice.

The normal operation of this inverter is to turn on the switching transistor until the transformer core material is nearly saturated, then turn off the transformer until the magnetic energy is completely transfered to the load (output).

If the output is low, (i.e. initial start-up or shorted load), the magnetic energy will transfer very slowly. If the transistor is turned on before transfer is complete, the transistor may be forced into linear operation and be destroyed.

Protection against this condition may be obtained by sensing emitter current and turning the transistor off before overload occurs, or by sensing transformer discharge and inhibiting turn-on until the secondary voltage has reversed and passes through zero. Emitter current sense is suitable only when the logic circuitry is common with the emitter (not is this case). The voltage sense could probably be incorporated with a few parts and the shutdown input of the SG1524 regulator chip.

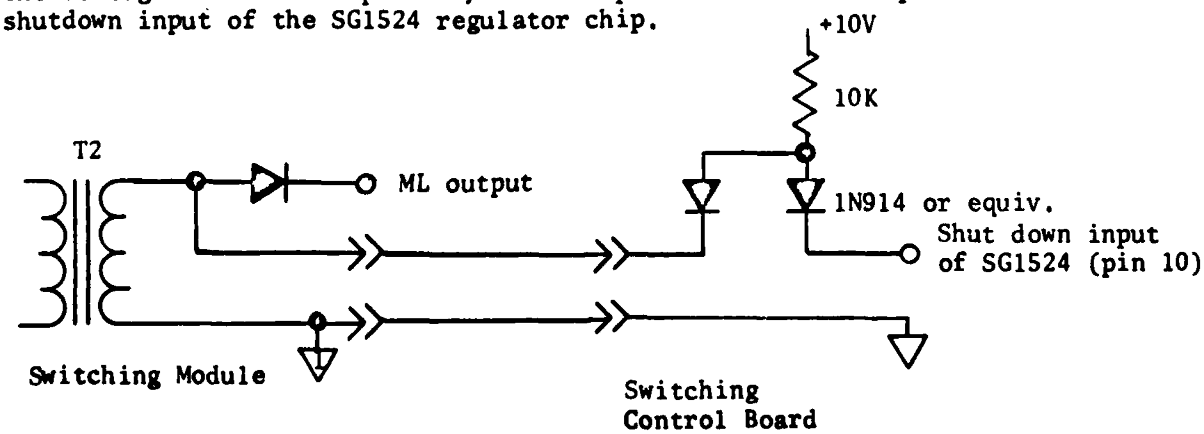


Fig. 5 Transformer Discharge Sense

The 150V, 10W zener diode on the primary of T2 is necessary to absorb the energy in the leakage inductance. If the primary and the secondary are tightly coupled, the zener can be reduced in rating or eliminated. T2 should be wound so that each primary turn is in close proximity to one or more secondary turns. Each secondary winding should have a low inductance path to a fast rectifier and low inductance capacitor.

Isolated base drive is always difficult to implement, and this circuit makes the usual compromises. T1 couples forward base drive from the N40026 clock driver, but reverse base drive is sacrificed to keep parts count low.

The NH0025 does maintain a low impedance state during the "off" period, but extraction of stored charge in the switching transistor is minimal.

Fortunately, the fall time of the Darlington transistor is somewhat invariant with reverse drive, and the single ended inverter can tolerate fairly long saturated delay times.

Unfortunately, the fall time determines the dissipation in the transistor, and Motorola specifies fall time with a high current, -5V turn off drive. Therefor each device used should be tested under actual operating conditions for acceptable fall times.

Reverse base drive can be accomplished by passing forward base drive through a capacitor and using the stored charge for reverse bias. In this regulator, short "on" times during start-up and low output would result in insufficient stored charge, and almost no reverse drive.

The NH0025 is a highly sophisticated clock driver meant for driving capacitive loads at fast slew rates. Its complexity is not warranted in this application, but it does the job in a small space.

It is inefficient, consuming up to 40 mA internally to drive 120 mA into T1. Its dissipation could be reduced by reversing its logic. As shown in Fig. 3, the "off" state is the high dissipation state.

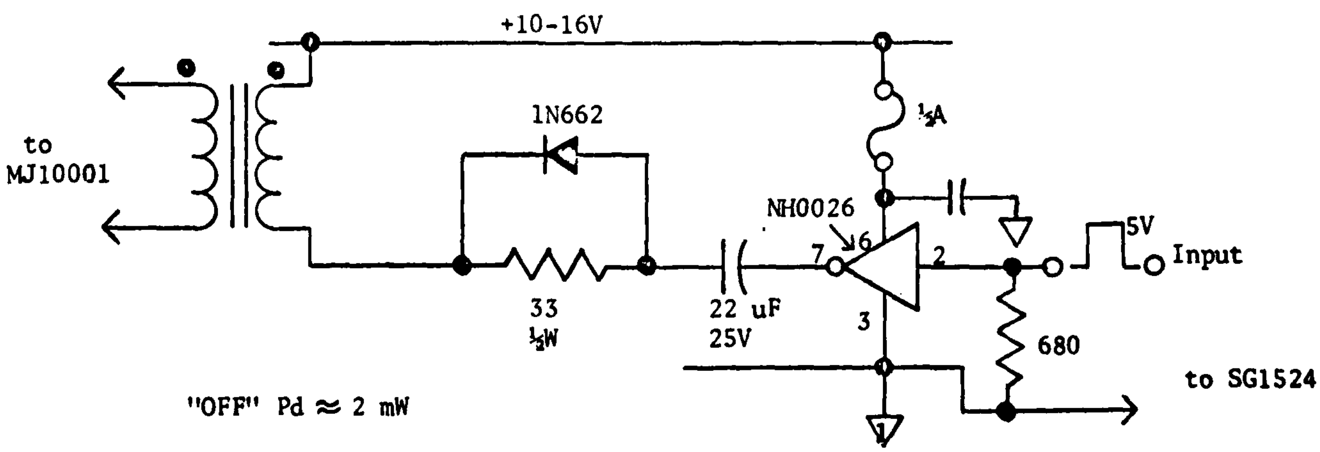


Fig. 6 Efficiency Improvement of NH0026 Driver

[redacted]

The unused half of the NH0026 could be used to generate reverse drive, or disabled by grounding its input.

If the housekeeping supply was regulated at +16V, and line voltage information developed by other means, the SG1524 outputs could drive the output transistors directly.

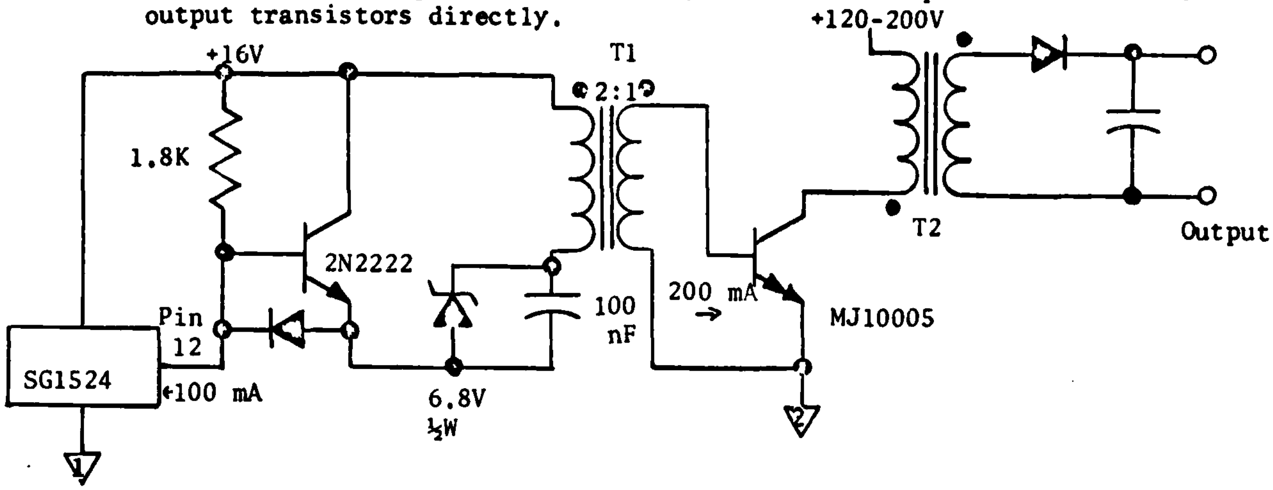


Fig. 7 Direct Drive from SG1524 with 16V Supply

This circuit will provide 200 mA of forward base drive and up to 2.5V @ 100 mA of reverse drive if the forward drive has been on for at least 5 microseconds. The dissipation in the SG1524 is increased, and its output current limiting is being used although it is not a specified parameter and would require testing each device. This circuit has a reduced part count than the NH0026 circuit and might prove more reliable.

SWITCHING CONTROL BOARD - Fig. 4

This module contains the pulse width modulation circuitry necessary to regulate the output. It uses four Silicon General SG1524 integrated circuits to allow independent control of the four switching modules. As shown in Fig. 4, the SG1524's are connected so some individual failures can interfere with operation of the other three.

The SG1524's share the 10 - 16 V supply, and an internal short will stop everything. If the driver circuitry is fused, each SG1524 could be powered from that fuse.

The internal oscillators are synchronized with diodes and 10 kilohm resistors. Loss of power to one SG1524 could stop the oscillator in the device ahead of it. Replacing the diodes with emitter followers would eliminate that interference.

As shown, the SG1524's are tied together at pin 1 in order to share the output current among the switching modules. As with the oscillator sections, loss of power to one would load the others. Also, the output current of a single error amp (internal to the SG1524) appears insufficient to drive the other three. A single external op-amp appears necessary to drive the SG1524's, probably through 10 kilohm buffering resistors. The inputs (pins 1 & 2) to the unused error amps should be tied to the internal 5 volts (pin 16) to avoid interfering with the SG1524's bias system.

A soft start system could be tied to the main loop output rather than the housekeeping supply. That will limit the conduction angle until the output has increased. This has the effect of foldback limiting and may not allow the output to start up into non-linear loads. The voltage sense circuit discussed earlier (Fig. 5) will allow full current into all loads.

CONCLUSION

The proposed supply appears to be very well suited to the components now available. The high voltage Darlington transistors and the integrated circuit switching regulator appear to make a very compact and simple power supply possible.

25 January 1977

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